Compliments of the Author

THE MILK-SUPPLY OF CITIES: CAN IT BE IMPROVED?

—MARCY

The Milk-Supply of Cities: Can it be Improved?

Presented to the Section on State Medicine, at the Forty-ninth Annual Meeting of the American Medical Association, held at Denver, Colo., June 7-10, 1898.

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BOSTON, MASS.

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THE MILK-SUPPLY OF CITIES: CAN IT BE IMPROVED?

Sanitation has made rapid strides in the protection of the public from a great variety of dangers, and more and more each year are emphasized the interdependence and correlation of the entire body politic. This is especially true in urban life, and many of the relations which were thought to be purely personal and individualistic are now accepted as common, and are to be most satisfactorily dealt with under general supervision and control. The development of the water-supply and sewerage of cities is an illustration of common needs, more and more demanding a union of public interests, supervised by men of the highest talent, specially trained for this service.

Modern science has pointed out many dangers to which the individual is exposed, and it is with special satisfaction that we refer to the labors of this generation in having defined the causation and limitation of a large class of the diseases to which the human race is liable.

Ever present—from birth to death—is the daily need of supplying the wants of the system with materials from which the vital economy extracts the products necessary to repair the waste and rebuild the organism. During the first year of life this is furnished almost exclusively by the maternal milk, or that from animals, and nearly every individual incorporates milk daily into his supply of food.

In nursing, this complex animal product is conveyed directly, without contamination, into the stomach, and therefore becomes easy of digestion and assim-

ilation. We have learned to know that milk is an excellent culture-medium for certain forms of bacteria, and that, because of these and other contaminations, it rapidly undergoes changes which are deleterious to the animal organism, and may be the means of diffusing disease in a variety of forms. In a very brief period after its production it becomes entirely unfit for food.

It is generally accepted that by far the larger single cause of mortality during the first year of life is owing to improper feeding—"bottle-fed infants." Dr. S. W. Abbott, Secretary of the State Board of Health of Massachusetts, in a recent paper entitled "The Saving of Children," says: "I have carefully examined the list of diseases in which an increased death-rate has occurred in Massachusetts, and have no hesitation in stating that boards of health in our large cities will find a fruitful field of work in the study of the question of infant mortality, its causes and the prevention of its excessive prevalence. Another reason for encouragement in this special direction is the fact that many lives saved in infancy are saved for a long and useful life, and are in fact so much added wealth to the community at large."

Dr. Schlossman says: "The death of every child constitutes a definite loss of national wealth. On the other hand, energy expended in saving the lives of the aged from the inroads of disease at the later periods of life only saves this class at a period when they are most likely to be a burden to the community."

Dr. Abbott quotes statistics to show that the death-rate of children under one year of age, per one thousand births, in Ireland from 1884–1888, was only 94, which is the lowest figure in foreign countries. In England it was 144, in France 165, in Massachusetts varying from 150 to over 200, and in the large cities often exceeding this latter percentage. It is generally conceded that this abnormally high percentage of death-rate is largely due to improper feeding.

How shall this, perhaps the most important of all our food supplies, be economically and safely furnished the public? is the subject to which I invite your attention and in its solution solicit your earnest co-operation. Manifestly, the first subdivision of the subject will be the source of the product—the animal furnishing the milk. Since man has almost exclusively selected the cow for this purpose, we will limit our inquiry to this animal. The improvement of the breeds of cattle is manifestly important, although the time at my disposal will not permit the discussion of this branch of the subject. It must be accepted that the animal furnishing the milk should be maintained in a state of health. This necessitates a proper feeding, healthy surroundings, a good water-supply, a certain amount of daily exercise out of doors, and protection from exposure and cold. It might be assumed that the interest which the owner of a dairy has in his herd, from an economic standpoint, would be a satisfactory guarantee in the securing of the public protection. Unfortunately, however, this is not true, and from a narrowly selfish standpoint the owner of the cow oftentimes considers her only as a machine from which to realize the largest possible product. Since this is estimated and sold as quantity rather than quality, the attention is often directed to the supplying of food products, accepted by the owners to be in a certain degree deleterious to the health of the animal, but recognized as stimulating to the milk secretion, as well as not seldom cheapening the keeping expense of the animal. Articles generally known as more especially damaging are the distillery products and certain imperfect forms of ensilage, more or less universally contaminated by various fungoid growths known as moulds, etc.

The owner's self-interest is also oftentimes, if not commonly, brought into collision with the public good in the employment of too little and a low grade of service in the care of the animals. This is at present very generally recognized in careless and

dirty methods of milking, especially during the period of housing made necessary by northern winters. The filth incorporated in the milk by the ordinary methods of stable-milking is a source of serious damage to the product, and if observed by the average consumer would be stigmatized as digustingly filthy.

These interests of the milk-producer, resulting from ignorance, carelessness and worse, so plainly conflict with those of the consumer, that the public has a right to demand that all the sources of milk-supply production shall be constantly kept under public inspection and control, viz., that a healthy animal furnishes a clean and healthy product for public consumption.

The second subdivision of the subject is: Having a good product furnished by the dairy, how can it most safely and economically be distributed to the consumer? By general consensus of opinion the clean milk should be cooled as rapidly as possible, since bacterial decomposition goes on slowly at low temperatures, and immediately put up in sterile receptacles. Since tin is in common use, boiling water and steam furnish safe and economic methods. When glass is selected, and for many reasons it is much to be preferred, after washing, sterilization is easily effected by dry heat. Once put up for the public use, the product should be exposed as little as possible in reaching the consumer. This is the great objection to the large can.

Some years since, as chairman of a committee having public inspection of the milk-supply of the city of Boston, we found the greatest contamination resulted from the dirty methods practiced by small dealers, in recanning in a filthy stable in pints and quarts for family use. This was often labeled as one cow's milk, and especially recommended for the use of children. The cheap corner grocery is another source of milk defilement, which oftentimes is kept in dirty surroundings, even living rooms, and sold in small quantities for the use of neighbors.

Until within a comparatively brief period milk-inspection, although demanded by law, has been a perfunctory and superficial affair. It was deemed of chief importance to prevent dilution and the incorporation of foreign substances. Dilution with pure water may be the least damaging to the consumer, although he does not obtain the full value of his purchase money, while the addition of coloring matter to give the milk a rich, creamy appearance, is not especially injurious.

The real dangers with which the public has to contend lie in the contaminations already referred to. Besides these there is the lack of economy necessitated by the rapid distribution of a product which deteriorates every hour after its production so rapidly that by the third day it becomes a waste product.

We admit that the problem is by no means easy of solution, and that in the aggregate it is of enormous magnitude; and yet modern science seems to be extraordinarily lacking in furnishing better means for supplying a universal want. Other food products are cared for much more satisfactorily, so that the consumer has his table supplied economically and safely from the markets of the world. We cease to marvel at the fresh salmon daily distributed, which comes to us in good condition from Alaska. We find poultry of the autumn, fattened upon the western cornfields, in good preservation during the months that follow; even the mutton from New South Wales vieing in the English market in quality with the Southdowns of the previous day's killing, which has, for its chief rival, Chicago beef, noted for its excellence in the great centers of both continents. Certain cheese and butter products have wide reputation, and deservedly so, because they are prepared from healthy dairies in the pure air of high Alpine fields. The last few years have seen a revolution in the manufacture of butter and cheese from milk brought to a common center from a large surrounding district. The products are so manifestly superior that they

bring higher prices in the open markets. These may be called *concentrates* of milk, and, because of their minimizing in bulk and keeping properties, are easily transported long distances to the great centers of consumption. This should pertain equally to the milk-supply, and in the abstract is a problem of comparatively easy solution.

In this paper I purposely avoid even touching upon the important questions of milk composition and the testings of its value, since in a general way, these are not only well understood by the medical profession, but also by the body politic. Sufficient for our present purpose has been the reference already made to the constant contamination to which milk is subject, from the moment of its production until its consumption. It is a well-known scientific fact that aseptically withdrawn from the healthy udder into an aseptic receptacle, and sealed at once without exposure, milk remains indefinitely in a state of preservation. By the present means employed for its abstraction from the animal, protection from contamination is impossible, although to me it seems evidently feasible that machines for milking could be adopted, which, in very large degree at least, would be preventive of this source of infection. Once having occurred, however, some means must be taken for its disinfection. This may be said to be readily done by boiling, but heat thus applied not alone changes the taste of the product, but also its composition, both the fat and casein being affected by it, and rendered far less nutritious and digestible. Heated to a lower temperature, about 170 degrees F—so-called Pasteurization—the cream and caseous products are less changed and the larger portion of the bacteria destroyed. This gives a safer milk and is much more economic in consumption, because it will keep much longer without spoiling.

Milk concentrates, the larger portion of the water having been extracted and condensed by evaporation in vacuo, until a semi-solid is the resultant, have long been familiar to all. They have their advantages and

are considered under certain conditions well nigh indispensable articles of food. Their use, however, is comparatively exceptional, because of undesirable changes resulting from the application of heat. By the abstraction of the water from milk, its bulk is lessened about 87 per cent. If removed without change of the solids, the addition of this amount of water would again give fresh normal milk. Removal by processes that would destroy deleterious contamination occurring in its production would render the product as permanent as that of butter and cheese, and as easy of transportation. The economic resultant would diminish the cost to the consumer about one-third, and give an article of food of far greater value and safety. How can it be effected?

I am indebted to my friend, William T. Sedgwick, professor of biology in the Institute of Technology, Boston, for much valuable information upon the subject of milk contamination, and the State of Massachusetts may well consider itself fortunate in the services which he has already rendered, in securing a better milk-supply. His publications upon the subject are more or less known to the medical profession. From a large series of bacteriologic investigations the following deductions are drawn:

Normal country milk produced by clean, healthy animals, drawn by hand with great care into sterilized bottles and planted quickly, yielded as an average of several trials 530 bacteria per cubic centimeter—the cubic centimeter roughly estimated as equal to a cube one third of an inch, or to a small thimbleful. When, however, the milkman used the ordinary milk-pail of flaring form, seated himself with more or less disturbance of the bedding, and vigorously shook the udder over the pail during the usual process of milking, we found that the numbers were very much higher, namely, an average of 30,500 per cubic centimeter, at the end of milking. When such milk is found upon the tables of country families a few hours later, it naturally shows still more bacteria, doubtless because those with which it was seeded have had time to multiply. The average of fifteen such samples from the tables of families in Jamaica Plain, Cambridge and Auburndale, was 69,143 per cubic centimeter. In these cases, moreover, the conditions of the cows and of the stables were exceptionally

good, while the milkmen were much more than ordinarily clean and careful.

It follows from these results that there are two principal sources of the bacteria in the milk, viz., contamination during the act of milking, and the natural multiplication of the bacteria thus introduced during the interval between milking and the consumption of the milk. The result of these investigations was to show that even under the most favorable conditions cow's milk, as ordinarily drawn becomes, almost necessarily, infected with hosts of putrefactive bacteria at the very outset. Under worse conditions, with unclean stables and dirty milkmen, to say nothing of half-cleaned pails and cans, it is easy to understand why milk swarms with bacteria; and, if we allow time also, the wonder is, not that it contains so many germs, but rather that it is still potable at all.

When we reflect upon the indescribably filthy condition of many cow stables; upon the fact that the cow's udders and flanks are not infrequently covered with flaking excrement; upon the quality of the men employed to do the milking, etc., etc., it becomes a simple matter to understand how this rich animal fluid—sterile at the start, but drawn by unclean hands into half-cleaned pails, and meantime sprinkled from above by the dust of the stable, by hairs, dandruff, dirt, and particles of excrement from the skin and udder of the cow, vigorously shaken by the milker or brushed by his hat—becomes infected with organisms. That these multiply swiftly and enormously in the warm and rich fluid, well aërated by the act of milking, is also a natural consequence of favorable conditions.

Of fifty-seven samples taken directly from the milk wagons and planted at once, the average number of bacteria were 2,355,500 per cubic centimeter. In sixteen samples taken from groceries, usually older milk than that found in the wagons, the average number of bacteria was 4,577,000 per cubic centimeter. Two samples collected from well-to do families upon the Back Bay showed an average of 1,488,000 per cubic centimeter. Forty-five samples of so-called "railroad" milk, that is produced at a distance from the city and shipped by rail, under favorable conditions even upon its arrival, contained an average of more than 500,000 bacteria per cubic centimeter.

Mr. S. C. Keith, of Boston, a graduate of the institute of technology, who has for two years devoted himself to the special study of milk products and their contamination, recently gave a most interesting lecture before the Boston Society of Arts upon this subject. He stated that he had made experimental bacteriologic studies during the last summer upon the milk from ninety-seven dairies, examined soon after

its arrival in Boston. Twelve per cent. contained less than 100,000 bacteria per cubic centimeter; 51 per cent. from 100,000 to 1,000,000; 25 per cent. from 1,000,000 to 5,000,000; and 12 per cent. over 5,000,000.

Professor Sedgwick quotes the investigations of Professor Renk of Halle, who found that the public milk-supply of that city varied from 6,000,000 to 30,000,000 per cubic centimeter, and he remarks by way of comparison that the sewage of American cities seldom contains, on the average, more than 1,000,000 bacteria per cubic centimeter.

Professor Sedgwick has not been willing to treat the subject from simply the standpoint of abstract science, and at the October quarterly meeting of the Massachusetts Boards of Health in 1897, and published in the JOURNAL, will be found the following rules, suggested by a committee of which Dr. Sedgwick was chairman, for adoption by Boards of Health of the State for the protection of milk supplies from pollution:

ARTICLE I.

SECTION 1. All persons engaged in the production of milk for sale, or in the sale, delivery, or distribution of milk in the city or town of . . . shall annually, on or before May 1, make written application, on forms prescribed by the Board, for a permit or license.

SEC. 2. No person shall engage in the business of producing milk for sale, or in the sale and distribution of milk, in the city or town of . . . after April 30, 189–, without a permit or license to do so signed by said Board of Health, and under such conditions as said Board of Health may impose, revocable at the pleasure of said Board.

SEC. 3. The conditions under which every cow is kept, whose milk is brought into any city or town, or kept, delivered, distributed, sold, or offered for sale, in such city or town, shall be made known to the local Board of Health in such detail as the Board may require, and shall be approved thereby; and no milk except that delivered from such cows shall be brought, kept, delivered, distributed, sold, or offered for sale.

SEC. 4. No milk shall be sold, offered for sale, or distributed in any city or town, unless the cows from which it is delivered have within one year been examined by a competent authority, and shown to the satisfaction of the local board of health to be free from disease.

SEC. 5. All persons having a permit or license to sell, deliver, or distribute milk in any city or town, shall keep a copy of the same constantly posted in a conspicuous place on premises and vehicles from which milk is sold or distributed or in which milk is kept or delivered.

ARTICLE II.

SECTION 1. No milk shall be kept for sale or distribution, or handled, tranferred from can, or stored in any stable or similar place, or any room used in whole or part for domestic or sleeping purposes.

SEC. 2. Milk shall be stored or regularly mixed, cooled, or poured from can to can only in a room not directly connected with a stable or stables, provided with a tight floor and kept constantly neat and clean, the walls of the room being of such a nature as to allow easy and thorough cleaning. The room aforesaid shall contain proper appliances for washing and sterilizing all utensils actually employed in the storage, sale, and distribution of milk in said building, and all such apparatus and utensils shall be washed with boiling water or sterilized by steam regularly after being used.

SEC. 3. No animal, water-closet, or privy shall be in the aforesaid room or any room directly connected therewith.

SEC. 4. All milk directly after it is drawn from the cow shall be at once taken to, and be at once filtered, cooled, and stored in a room such as is described in Article II, Sections 1 and 2.

ARTICLE III.

SECTION 1. Milk kept for sale in any store, shop, market, bakery, or other establishment, shall be always kept in a covered cooler, box, or refrigerator, properly drained and cared for; and while therein shall be tightly corked or closed, and only in such location and under such conditions as shall be approved by the local board of health.

ARTICLE IV.

SECTION 1. All cans, bottles, or vessels of any sort used in the sale, delivery or distribution of milk to the consumer must be cleaned and sterilized by the milk dealer before they are again used for the same purpose.

ARTICLE V.

SECTION 1. Every person engaged in the production, storage, transportation, sale, delivery, or distribution of milk, shall immediately on the occurrence of any case or cases of infectious disease, such as typhoid, scarlet fever, or diphtheria, either in himself or in his family, or among his employes or within the building or premises where milk is stored, produced, sold, or distributed, take care that the local board of health is notified of such case or cases, and at the same time suspend

the sale or distribution of milk until authorized to resume the same by the local board of health.

SEC. 2. It shall be unlawful for any person suffering from a contagious or infectious disease, such as typhoid, scarlet fever, or diphtheria, to handle, transport, deliver, mix, taste, work over, or distribute milk, or in and about places where milk is stored, sold, or distributed, or to serve as a milker or milkman. No vessels which have been handled by persons suffering from such diseases shall be used to hold or convey milk.

A long discussion of these rules was entered into by the members of the Massachusetts Boards of Health, which resulted in their adoption, and as a fruitage thereof, I subjoin the following order issued by the Board of Health of the town of Montclair:

BOARD OF HEALTH.

AN ORDINANCE CONCERNING THE PRODUCTION OF MILK AND REGULATING ITS SALE AND EXPOSURE FOR SALE IN THE TOWN OF MONTCLAIR.

Be it ordained by the Board of Health of the Town of Monclair, in the County of Essex, as follows:

SECTION 1. Every person, corporation or association of persons who now is or who hereafter shall be engaged in the sale, or exposure for sale of milk within the Town of Montclair, before selling or exposing the same for sale, shall furnish the Board of Health of the Town of Montclair a true and complete statement as to the locality from which the milk so sold or exposed for sale is produced; also a full and complete list of the names and addresses of persons from whom the said milk was purchased, and the names and addresses of all persons to whom they are regularly selling or delivering milk within said town; said lists shall be furnished to the said Board on the first days of January, April, July and October of each calendar year, and at all other times when requested by the said Board.

SEC. 2. No milk shall be sold or exposed for sale in the Town of Montclair except milk from cows stabled under light, dry and well ventilated conditions, and in all other respects conforming to the requirements hereinafter set forth, viz:

a. Each cow shall have at least three feet in width of floor space when fastened in stanchions, and in all cases where no adequate artificial means for ventilation are provided, each animal shall have an air space of at least five hundred (500) cubic feet.

b. All stables for shelter of said cattle shall be provided with a tight, dry floor. The manure drop shall be water-tight, and if constructed of wood shall be asphalted, tarred or otherwise made non-absorbent.

c. The walls and ceilings of said stables shall be whitewashed whenever it may be deemed necessary by this Board of Health.

d. Manure shall not be allowed to accumulate in large quantities in stable yards, nor near the buildings where the cattle are kept, and when stored temporarily in such places it shall be removed at least once per month. The said stable yards shall be drained and kept in a clean, dry condition, and no accumulation of household garbage, vegetables or other putrescible matter shall be allowed to remain or decay in said stable yards.

e. Cattle shall at all times be kept in a clean condition, and udders shall be washed, hand-rubbed or wiped with a clean, damp cloth before each milking.

f. No milk shall be sold or offered for sale or distributed in the Town of Montclair, unless the cows from which it is obtained have, within one year been examined by a competent veterinarian, and are free from diseases dangerous to the public health. But this shall not be construed as forbidding the sale or use of milk from cows not tested with tuberculin.

g. No milk shall be sold or offered for sale or distributed in the Town of Montclair, obtained from any cow that has calved within ten days, or from a cow which will come in or calve within sixty days.

SEC. 3. No milk shall be sold or exposed for sale in the Town of Montclair, except milk produced from cattle fed and watered under the following conditions: All food given to such cattle shall be fresh, sweet and wholesome. The use of either distillery slops or fermented brewer's grains is prohibited, and their presence on any dairy premises will be considered sufficient cause for the exclusion of the milk from such dairy from sale or delivery in said town Water supplied to cattle shall be pure and free from all contamination by stable or household drainage, and no well or spring in or adjoining any stable yard shall be used for watering said cattle.

SEC. 4. All milkers and other attendants employed in any dairy, the milk from which is to be sold or offered for sale or delivered in said town, shall be personally clean. Before entering upon their duties connected with the dairy, hands shall be washed, and clothes changed or brushed, and no milk shall be delivered or sold or exposed for sale in said town, produced from dairies wherein the foregoing regulations are not enforced.

SEC. 5. Utensils used for the collection and transportation of milk shall, before being used, be thoroughly washed with pure water and soda or soap, and then sterilized by boiling or steaming.

SEC. 6. Milk which is to be delivered or sold or offered for sale in said town shall, immediately upon being drawn from the cow be removed from the stable to a room separate and apart from the said stable, and immediately cooled by submerging

the vessel in which the milk is contained in cool water to a depth equal to that of the said milk in the vessel. The above mentioned room shall be properly ventilated and lighted and shall be used for no other purpose than that indicated above, and shall at all times be kept in a clean condition.

SEC. 7. The said milk shall be delivered in bottles unless permission for delivery in another manner shall be granted by said Board. No tickets shall be used in connection with delivery of milk.

SEC. 8. If at any time any person or persons having any connection with a dairy from which milk is delivered or sold or offered for sale in the Town of Montclair, or any resident member of the family of any person so situated, shall be stricken with cholera, smallpox, (including varioloid), diphtheria, membranous croup, yellow, typhus, typhoid or scarlet fever, measles or any other communicable disease that may hereafter be declared by this Board to be dangerous to the public health, notice shall be given to said Board immediately, by th eowner or owners of such dairy, and no milk produced from the dairy of any corporation, person or association of persons failing to give the notice herein required, shall hereafter be sold or exposed for sale or delivered in the Town of Montclair, until special permission therefor has been granted by said Board.

SEC. 9. Any person, corporation, or association of persons, violating any of the provisions of this ordinance, shall, on conviction thereof, be liable to a penalty of not less than ten nor more than one hundred dollars.

SEC 10. All ordinances or parts of ordinances inconsistent with the provisions of this ordinance are hereby repealed.

Passed March 25, 1898.

D. D. DUNCAN,
President.

Attest:
R. P. FRANCIS, Secretary.

My friend, Dr. J. Cheston Morris of Philadelphia, one of the best-known authorities upon the subject of milk-supply and distribution, writes me under recent date and in reply to the question, Where can milk be most satisfactorily produced? "On a farm where the animals can browse contentedly on green grass, near running waters, and can find good shelter, plenty of hay, corn fodder, corn and cob meal in winter warm, well-lighted and aired stables. Keep animals clean, dry, well-fed and freely exercised. Stimulate them unnaturally and disease may follow. Breed only from healthy animals and avoid unhealthy care-takers. My Devon cows are giving me about five and a half

times their weight in milk per annum, which furnishes four quarts of cream or four pounds of butter from twenty-eight quarts of milk. I think a machine that keeps itself in order and produces a new machine annually, beside five and half times its own weight, without undue urging, a pretty good machine, and I am satisfied. I do not believe we can preserve milk as it comes from the cow and with digestibility undiminished for more than thirty-six to forty-eight hours."

Dr. Morris refers to a very recent discussion having taken place in Philadelphia over the best methods of handling and distributing milk, resulting in the approval by the Board of Health of the glass jar distribution, well known to have been originally introduced by Dr. Morris. The advocates of the large-can process of distribution objected to the glass-can system on the ground that contagious disease might be carried from house to house by imperfectly disinfected jars, but Dr. Morris states, "I showed that I had carried on this method of distribution for more than twenty years without a single case of such carriage, either among customers or at the farm; that for the farmer's own protection, as well as for his profit, absolute practical disinfection for each jar is indispensable."

It is apparent that a rigid supervision under State authority would do much toward the protection of the public, by furnishing milk produced by healthy cattle, kept reasonably clean, sent to market much cleaner and better preserved; in a word, safer for public consumption.

As shown by Professor Sedgwick, to a degree at least, it is necessarily an infected article and consequently must undergo decomposition within a limited period, that placed by such a distinguished authority as Dr. Morris not exceeding forty-eight hours.

Dr. Morris' method of requiring each producer to put up his milk in pints and quarts in glass jars, with the name of the dairy and the date of milking has

manifest advantages. Any defect in the supply or cause of disease, as, in illustration, the repeated occurrence of typhoid fever (epidemics disseminated by the milk-supply) can be easily traced. It also stimulates rivalry and fosters a local pride among the farmers. It is noteworthy to observe the much better keeping quality of milk thus prepared for the market.

Illustrative specimens were shown by Dr. Morris, when lecturing upon the subject some time ago in Boston, that were perfectly fresh and sweet when the jars were opened four days after the milking, although subjected to the long journey from Philadelphia.

On a model farm near Boston the process of milk preservation is carried on in the following simple and effective manner: Having been milked as cleanly as possible, the milk is poured into a receptacle and by gravity finds its way through a series of strainers into an adjoining apartment having no other connection with the stable. Here it is quickly refrigerated and put up for market.

To aid in a cleaner process of milking, a pail has been devised called the "climax milkpail." It consists of an ordinary pail with a tightly fitting cover with two openings from which funnels project considerably above the surface of the cover. The bottom of these funnels is covered with close-meshed wire strainers. By its use much of the dirt which ordinarily falls into the pail from the udder is avoided. Pure rubber covers of a size to enclose the entire teat ending in a rubber tube, to conduct the milk into a closely covered pail could be used without much difficulty after a little practice with them on the part of the milker. They would be of the highest service, cheap, easily cleaned, and with reasonable care, furnish an almost absolutely sterile milk.

Mr. Horlick of Racine, Wis., quite recently described to me a most ingenious device for milking cows by a machine, the power of which is furnished by an electric motor. It is said in many ways to

work satisfactorily, and by an ingenious combination may be applied to the milking of even fifty cows at the same time. All these methods are advancements in the right direction, to which may be added what, in a limited degree, has already been carried into effect—the process of sterilization by the application of a low grade of heat, Pasteurization, that is, maintaining the milk for a considerable period at a temperature of about 170 degrees F., not high enough to be detrimental to the albuminoids. Even if sterilization by this method is effected, contamination is sure to follow upon subsequent exposure to bacterial infection.

The secretion of the mammary gland is the product of certain epithelial cells. By their transforming power they manufacture from the blood a mixture of fat, sugar, and salts in a watery solution which we call milk. It is in fact strictly an animal food of unstable composition and is easily decomposed under the action of bacterial development. A pound of very lean beef and a quart of milk each contain about the same quantity of actual nutritious material. The taste which is objectionable in sterilized milk may be modified by pouring the milk from one receptacle to another, thus aërating it. In certain parts of the country Pasteurized cream has become popular. It is more conveniently handled and, freed in large measure from bacteria by the process, will keep for days without souring. It is objected to because of its lack of consistency, being thinner and less viscous. The Wisconsin Agricultural Experiment Station, after a careful study of the subject, recommends the use of lime dissolved in a solution of granulated sugar. This is called "viscogen," on account of its viscous producing properties, and the treated products are called visco-cream, visco-milk, etc. Only one part of viscogen to one hundred and fifty parts of cream is required, and the small quantity of lime added according to this rule only amounts to about four parts in 10,000, which, instead of being detrimental to the health, is rather beneficial.

In several European cities sand filtration of milk is employed at a central depot after its arrival from the country. The filters consist of large cylindrical vessels, divided by horizontal, superposed compartments, of which the middle three are filled with fine, clean sand, sifted into three sizes, the coarsest being placed in the lowest and the finest in the topmost of the three compartments. The milk enters the lowest compartment through a pipe under gravitation pressure and, after having traversed the layers of sand from below upward, is carried by an overflow to a cooler fed with ice water, whence it passes into a cistern, from which it is directly drawn into locked cans for distribution. Milk thus treated is not only free from dirt, but the number of bacteria is reduced to about one-third. In new milk the loss of fat is said to be very slight, but the quantity of mucus and slimy matter retained in the sand is surprising. The sand is renewed each time the filter is used.

The live stock interests of our country are so enormous that it is difficult to form a just appreciation of their value. According to the census of 1890, there were that year in the United States between fifty-one and fifty-two millions of cattle, calves born over sixteen and one-half millions, and the total number of milch cows were 16,511,950, of an estimated value of over $4,000,000,000. The milk-supply for 1889 reached the enormous aggregate of 45,210,125,567 gallons, worth on the farm over $651,000,000.

The census of 1890 gives us the latest reliable data, but there has been a material increase in the value of the milk-supply in excess of the ratio of the increase of population. It is only by comparison that such enormous amounts can be appreciated. The total value of all the mineral and metal products, including coal, of 1896 are given as follows:

Belgium	$100,000,000
France	110,000,000
Germany	300,000,000
United Kingdom	340,000,000
United States	737,958,761

Some years since Mr. Edward Atkinson of Boston showed that the *hen* was a greater producer of material wealth than the gold mines of the country. From the above figures we note that the *cow*, by her milk product alone, is a source of wealth not far below that of all the mineral products of the United States.

The butter product for 1889 was 1,024,223,468 pounds and the cheese product for the same year was 18,726,818 pounds. The average quantity of milk produced for milch cows during the year 1889 was $315\frac{54}{100}$ gallons, and to each individual in the United States for the year was $83\frac{1}{5}$ gallons, or nearly one quart per day for every man, woman and child in the entire country. Estimating that six-tenths of the product was canned and shipped for distribution, the amount thus disposed of was 25,008,602,718; analytically 87 per cent. is water, and at least 75 per cent. of the water should be removed before shipment. The amount of *water* thus expensively distributed with only attendant loss, is so enormous that it can be appreciated only by means of comparison—18,756,452,037 pounds equal 9,378,226 tons =468,911 car loads each of 20 tons =11,725 train loads, each of forty cars =2931 miles of continuous trains, reaching nearly from the Atlantic to the Pacific Oceans if thus placed to span the continent!

Were it possible to eliminate this enormous percentage of waste without damage to the resultant product, the gain would be almost beyond comprehension.

G. W. Goddard of Cambridge gives the following figures from New York City Board of Health Report: 1896, pp. 90, 91. Daily average of cows' milk and condensed milk shipped to New York City: Milk 828,612 quarts, cream 16,000 quarts, condensed milk 8600, a total of 853,212 quarts. To give milk equivalent to the cream add 64,000 quarts. To give milk equivalent to the condensed add 19,800 quarts, making a total of milk-supply 937,212 quarts, condensed 75 per cent. of the whole; 87.7 per cent. of above is

produced in New York State; in New York City 2200, in State 1,112,370, in all 1,114,570 cows. Total cost at five cents per quart, over $60,000,000 per year.

The Agricultural Department at Washington has just issued one of its bulletins, treating of the milk-supply of Boston and other New England cities, and prepared by Mr. George M. Whitaker, executive officer of the Massachusetts State Dairy Bureau. The Greater Boston, namely, within a radius of ten miles from the State house, contains a population of one million, or eighteen per cent. of the population of New England.

About three-fourths of the supply of milk for this section is sent by railroads, the greatest distance for direct shipment is 140 miles. For the most part the milk is conveyed in cans especially constructed for this purpose with refrigerator closets, etc. The milk thus supplied is from eighteen to thirty hours old before it reaches the consumer. Boston was the pioneer city in this country in the transportation of milk by railroad. The first man to engage in this business was Jason Chamberlain, who began operations sixty years ago upon the Boston & Worcester railroad. He sold milk at twenty-five cents per can of nine and a half quarts. In 1843 there was printed in the *New England Farmer* an article upon the subject. It states. "We have learned that one man brings in upon the Worcester railroad 200,000 gallons annually. This is supposed to be one-tenth of all that is sold in the city. This at twenty cents a gallon costs the citizens $400,000 per year." Today fully three-quarters of the milk supplied to Greater Boston passes through the hands of large wholesalers, locally known as contractors. There is a considerable increase in the consumption of milk in Boston each year. The total for 1895 was about 18,000,000 gallons—in 1897 the supply had increased nearly 700,000 gallons. Within the ten-mile radius there are over 7000 cows.

Mr. B. F. McIntyre, of McKesson & Robbins, New York, has recently published some interesting articles

upon the condensing of milk by a process of refrigeration when the milk is in agitation. His more recent publication is found in the *Milk Reporter*, January, 1897. His experimental studies were carried on at Cattaraugus, N. Y., under favorable refrigerating conitions. The product met the approval of dealers from both the commercial and economic standpoint. His process is briefly summarized as follows:

1. Reducing the bulk of the milk by conversions of the water of the milk into ice, instead of vapor or steam.

2. The making of the ice on the surface only of the milk, by elevation of the freezing pans in an atmosphere of zero temperature or thereabouts.

3. Frequent breaking of the surface ice so that fresh liquid is presented to a freezing effect, with gradual submersion of the broken ice as the bulk of ice increases.

4. Standardization of the product.

Considerable difficulty was experienced in the selection of milk free from "cow-odor." Milk with a perceptible taint of animal odor is unfit for condensation by cold processes as thereby these odors are intensified. The fats are removed by a cream separator which should be set to run heavy cream and which should assay not less than fifty per cent. milk fat. Running into the separator is of much value in freeing the milk from dirt and foreign animal products. From the separator the fat-free milk was run over a bank of horizontal copper pipes through which ice water was circulated reducing the temperature of the milk from 80 to 35 per cent. F. By this process of condensing there is no thickening of or chemic change in the albuminoids, such as takes place when the milk is reduced by heat in vacuo. A condensation of five and one-half gallons to one gallon is required to produce a product with the desired consistency. By this freezing process one hundred gallons of skim-milk are reduced to thirteen gallons of very thick milk which represent in milk, sugar, caseine

and inorganic salts fully nine gallons of solids. Eighty-seven gallons of water in the milk are formed into ice. An average sample of the snow-like ice, when melted and evaporated to dryness contained .2 per cent. of residue. A final step in the process was the admixture of the heavy cream in proper proportions with the concentrated fat-free milk. In keeping properties the new form of condensed milk is superior to whole milk, as the freezing temperature at which the milk is held is destructive of some forms of germ life common to milk, and the natural life of the preparation is prolonged by this partial sterilization."

I am in receipt of letters from Mr. McIntyre, of recent date, in which he states, that "unfortunately the plant at Cattaraugus has recently been burned," and in reply to my inquiry as to the expense attendant upon this process of condensation, he states: "The cost of the manufacture of ice *per se* from milk is not so very much greater than making it from water. My process could be designated as a method to produce ice in crystal form, instead of in solid or cake form, and the solids of the milk might be considered as a foreign admixture to the water being subjected to the freezing effect. I claim, and have the judgment of experts, that my process will produce as much ice daily from a given weight of coal, as will be produced in the ordinary ice-making process. Ice made from distilled water is sold in New York in midsummer at $2.00 per ton."

If the condensation can be carried on by a process by which the water of the milk can be extracted at any such cost as above estimated, it will at once be accepted as of the largest value. It seems feasible and merits a careful consideration, as introducing a possible new factor of the greatest value in furnishing economically a daily product of such an indispensable character as milk.

The condensation of fluids in vacuo has been economically conducted, at a very recent period, at a

much lower rate of temperature than was formerly deemed possible. I am advised by two New York chemists that one of our large manufacturers of malt products is successfully carrying out a process with the temperature as low as 110 degrees F., in vacuo and it is believed not improbable that milk can be evaporated to dryness at a temperature of 100 degrees F. This temperature would scarcely affect in any way the albuminoids and would leave a product unchanged except for the abstraction of the water.

It seems thoroughly feasible to treat milk in large quantities by abstracting the great bulk of the water through refrigeration, thus practically sterilizing the resultant product. This product, treated by evaporation, either in vacuo at a low temperature or by a warm air blast, the heat-point of which is regulated so that the resultant product may be in the form of granules, cakes, or of a consistency not unlike that of butter or cheese, all possessing good keeping quality, would, upon the addition to it of the proper percentage of water, furnish fresh milk at will.

In these days of rapid progress the public is accustomed to accept radical changes, when demonstrated for the better, with very little of comment. The immense problem which I have thus all too briefly outlined, viz., furnishing vastly more economically a safe and satisfactory milk-supply is worthy the attention of all sanitary scientists. Clearly formulate the *want* and show the manifold advantages resulting from *better methods*, and science at once steps in and demonstrates the *way* for their attainment. This, I believe, will early be accomplished. The milk-supply of the world will be economically revolutionized, to the manifest advantage of every individual.

A further study of Mr. McIntire's processes increased my interest in the subject until, after a correspondence of some length, I induced my friend, Mr. George M. Goddard of Cambridge, a well-known expert in the processes of refrigeration, to visit New York and carefully examine the method advocated by

Mr. McIntire. The outcome of this, through Professor Sedgwick, has been to secure the active co-operation of Mr. Edward Burnett, who has devoted a large share of his life to the scientific studies relating to agriculture, and especially the better methods of milk production and distribution. Mr. Burnett's large milk-plant at Southboro was placed at Mr. Goddard's disposal and the summer occupied in a careful practical study of the processes. Samples of the concentrate were distributed for experimental use. Those which came under my observation proved in every way satisfactory. The oldest specimen examined, having been kept thirteen days, was perfectly sweet when opened. A careful series of bacteriologic tests, by the request of Professor Sedgwick, were undertaken by Prof. G. M. Holman, of which the following tables furnish brief samples:

TABLE I.—First Series (Aug. 1, 1898.)

Sample.	Bacteria per c.c.	
1 Whole milk	267,400	Numerous liquefiers.
2 Skim milk (pan)	432,600	
3 First condensation	394,200	Odorless plate.
4 Second condensation	175,000	Mouldy cheese odor.
5 Third condensation	24,000	Sweet butter odor; 1100 liquefiers.
6 Fourth condensation	19,400	Sour milk odor; few liquefiers.
7 Past'rized cream prod	175,000	Mouldy odor.
8 Raw cream product	2,616,100	Many moulds.
9 Raw cream product	2,759,400	
10 Pasteurized cream	0	Plate covered with moulds (mucus).
11 First ice	6,370	Some moulds.
12 Second ice	3,444	Some moulds; badly liquefied.
13 Third ice	1,470	Many moulds; badly liquefied.
14 Fourth ice	17,000	
15 Ice from 19 hours' freeze (July 20-21).	6,035	

TABLE II.—Second Series.

Sample.	Bacteria per c.c.	
1, Skim milk	152,400	
2, First condensation	10,200	
3, Second condensation	7,700	
4, Third condensation	6,100	
5, Fourth condensation	2,000	
6, First ice	300	
7, Second ice	185	
8, Third ice	5,320	
9, Fourth ice	7,300	
10, Raw cream product	612,360	
11, Pasteurized cream product	9,200	
12, Pasteurized cream	11,300	
13, Raw cream	14,742,000	Badly liquefied; bad [smelling plate.
14, Borden's evaporated cream	0	
15, Boston condensed (unsweetened)	1,134,000	

TABLE III.—First Series.

Sample.	Solids, per cent.	Ash. per cent.	Fats, per cent.
Whole milk	13.29	0.87	4.5
Skim milk	9.32	0.7	. . . . .
Raw cream product	34.73	1.61	15.36
Fourth condensation	17.45	2.02	. . . . .
Nineteen hours' ice (20–21)	0.49	0.05	. . . . .
Third ice	1.38	0.07	. . . . .
Second Series.			
Raw cream product	44.1	. . . . .	19.7
First condensation	15.0	. . . . .	. . . . .
Second condensation	23.39	. . . . .	. . . . .
Third condensation	35.49	. . . . .	. . . . .
Fourth condensation	36.18	. . . . .	. . . . .
First ice	1.15	. . . . .	. . . . .
Second ice	2.47	. . . . .	. . . . .
Third ice	5.96	. . . . .	. . . . .
Fourth ice	21.97	. . . . .	. . . . .
Borden's condensed	30.2	. . . . .	3.7
Boston condensed	38.5	. . . . .	0.3

No pathogenic germs in "Refrigerated Condensed."

Test from run of Sept. 3, 1898.

Samples.	Bacteria per c.c.	Solids, per cent.
1, Whole milk	90,000	13.43
2, Skim milk	78,500	9.34
3, Raw cream product	17,400	39.88
4, First condensed	17,900	14.28
5, Second condensed	6,800	22.73
6, Third condensed	8,300	24.6
7, First ice	1,382	0.37
8, Second ice	5,700	4.25
9, Third ice	11,250	8.04
10, Third ice, after three extractions	5,100	18.85
11, Raw cream	14,000,000	. . . .
12, Pasteurized cream	37,000	. . . .
13, Pasteurized cream product	5,600	. . . .

Reduction of bacteria from the whole milk to the finished (Pasteurized cream) product, 94.2 per cent.

It will be noted that the bacteria are very greatly diminished by the refrigerating process, although the product is not absolutely sterile. A special plant is now being established, where it is believed that much better work may be accomplished with a great reduction of cost. The daily output will be at the beginning 600 gallons reduced to 100 gallons, the product having already been disposed of. It is confidently believed that the result will assure an abundant reason why the milk distribution may be greatly improved, giving a far more reliable product, of good

keeping quality, at a much less cost to the consumer. If, for commercial reasons, it does not prove profitable to carry the process of concentration above the result outlined, the ordinary family supply of milk may be furnished weekly instead of daily and a far better product obtained than that of the present.

I have in my possession a specimen of powdered milk made by Mr. McIntire nearly two years ago, in a state of good preservation; thus demonstrating that the so-called butter fat of milk can be preserved in mixture. Mr. McIntire is of the opinion that it is easy to concentrate the solids of milk to a consistency not unlike butter or soft cheese, which will require only the addition of a proper amount of water to restore it to a sweet, wholesome, fresh milk, containing its proper quantity of normal cream. The keeping quality of this product will be such that it will come into world-wide distribution.